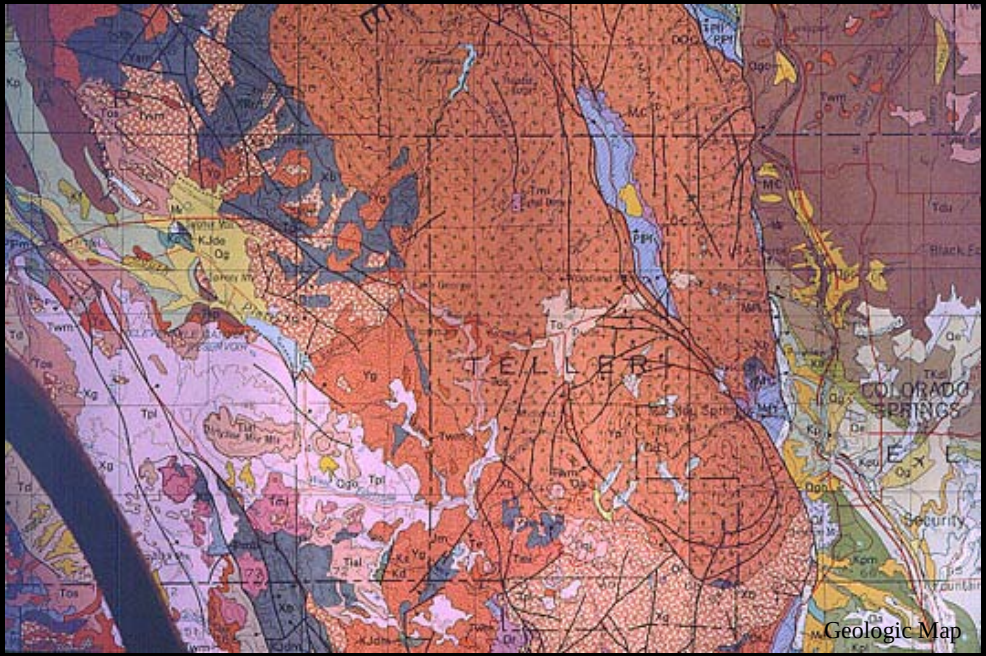
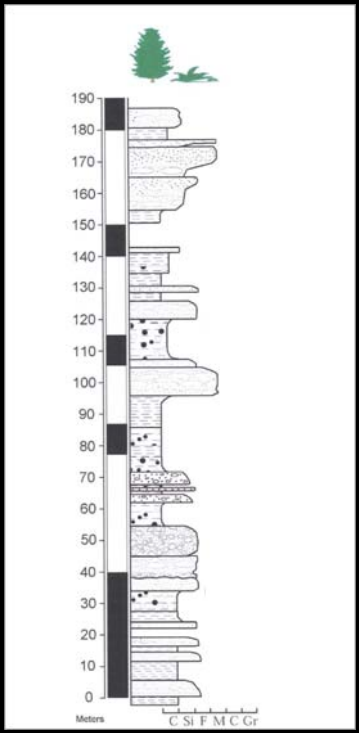
Paleontology is the science of studying ancient life. To do this we have to find fossils, or clues, and put them together to form a picture of the past. This slide show will examine the ways we put those clues together and how we interpret them.



Geologic Map

Putting Together the Pieces

Because fossils only form under special conditions, they are only found in certain types of rocks. Geologists make maps of different types of rocks and where they are found. Each color on the map shows a different geologic rock formation.



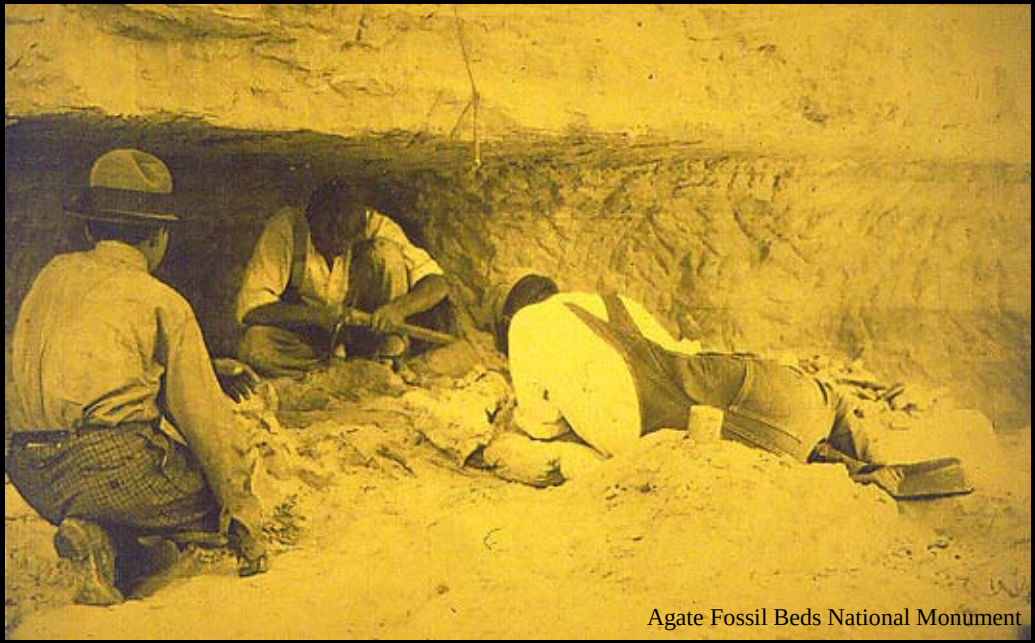
Stratigraphic Column

Putting Together the Pieces

Paleontologists use information from geologic maps and what they know about different rock formations and the kinds of rocks that fossils form in, to get a better idea of where to look for fossils.

Putting Together the Pieces

Once they know where to look, they may spend weeks combing the area for fossils that have eroded out of the rocks and are exposed on the surface.



Putting Together the Pieces

In the early days of paleontology, when geologists found fossils they would simply dig them up and take them back to places where they could be displayed.

Putting Together the Pieces

Today we have a better understanding of all the clues that the rock around a fossil can offer, so excavations are completed very carefully. Each site is carefully mapped, photographed, and notes are taken about depths and orientation of the fossils.

Putting Together the Pieces

Then a decision is made about how to deal with the fossil. If it is too fragile, or the surrounding rock has many clues about the ancient environment, it may be left in place. If the fossil can be removed, it is carefully "reliefed", with the surrounding material meticulously chipped away.

Putting Together the Pieces

Then it is surrounded with rags wet with plaster. When this hardens, it makes a cast around the fossil, so it will be safe until is taken back to the laboratory.

Putting Together the Pieces

Sometimes moving these fossils can be quite a job! Especially if the dig site is located in a remote area.

Putting Together
the Pieces

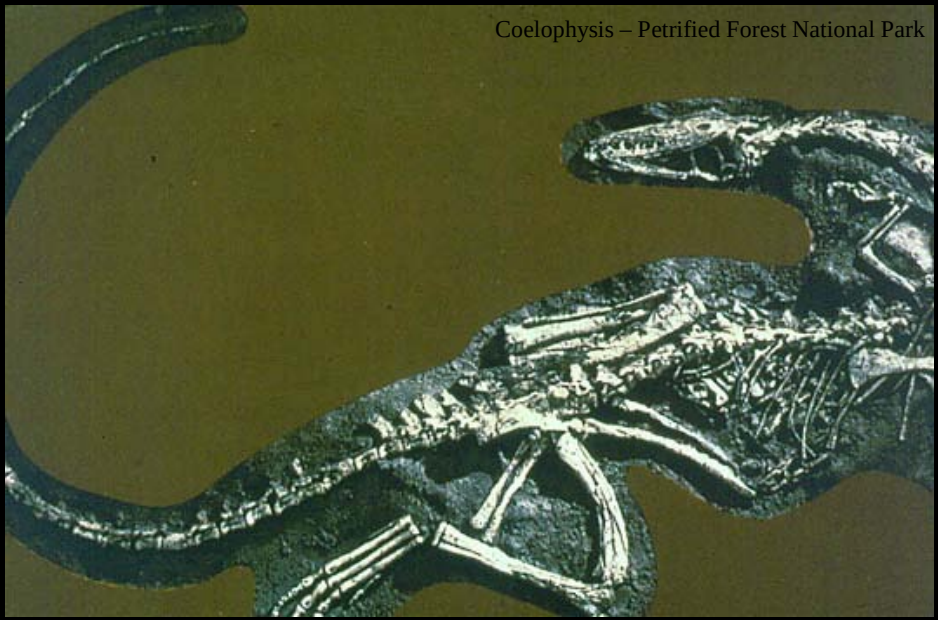
Helicopters are sometimes used.

Putting Together the Pieces

Once in the lab, very delicate care is taken to remove the plaster cast and the rock surrounding the fossil.

Putting Together the Pieces

and sometimes the fossil is studied on a microscopic level.



Putting Together the Pieces

Sometimes an entire, complete skeleton is discovered, but usually just some of the bones of an animal are found and the bones have to be placed back together again to get an idea of what the animal looked like.

Pronghorn Antelope

Putting Together the Pieces

Paleontologists use a technique called comparative anatomy to get clues. They study modern animals that seem to be similar for clues about how the bones fit together, the size of muscles that attach to certain types of bones, and how those muscles work, to come up with an idea of what the animal looked like and how it moved.

Putting Together the Pieces

Certain characteristics of bones help to identify the family of animal that they originated from. Bird bones, like this bone from a swan that lived at Hagerman Fossil Beds National Monument about 3 million years ago, are hollow, and are easily differentiated from mammal bones, based on this characteristic. Also, different types of bones yield more information than others. By examining a leg bone and using comparative anatomy and physics, a paleontologist can learn about adaptations the animal had for digging, running, climbing, or catching prey, for examples. However, rib bones would only give clues to the general shape of the animal's torso.

Putting Together the Pieces

Teeth can tell us what an animal ate. Herbivores, like this oreodont from Badlands National Park, are plant eaters and have squared, flat teeth for grinding up plant matter. These teeth are very different . . .

Putting Together the Pieces

. . .from the sharp, tearing teeth of a carnivore (meat eater) like this borophagus, a hyaena-like dog found at Hagerman Fossil Beds National Monument in Idaho.

Syndyoceras – Miocene Deer – Agate Fossil Beds NM

If bones from several animals are found together they can provide clues about interactions. If they are from different kinds of animals we learn about different associations. If they are from the same kind of animals we can learn about the social structure that may have existed between those animals.

Putting Together the Pieces

Sometimes fossil animals are discovered that are ancestors of modern day animals. This parahippus was an ancestor of the horse family, and looked similar to modern day horses except it had three toes instead of one (a hoof).

Putting Together the Pieces

We can look at the evolution of the horse family through time by looking at their fossils. The Hagerman horse, Equus simplicidens, roamed the ancient landscape of Idaho 3.5 million years ago.

Putting Together the Pieces

We can study the skeleton to see how the horse family changed and evolved with time.

Putting Together the Pieces

And compare it to modern members of the family, like the Zebra. We use the modern animal to learn more about the ancient one.

Putting Together the Pieces

Also, when we find fossil animals that are ancestors of modern day animals we can look at the modern descendants of that family of animals and infer how the animals may have interacted. This stenomylus from Agate Fossil Beds National Monument is an ancestor of camels.

The concept of looking at the present as a key to the past is called uniformitarianism. It is long word that means something very simple. The processes that we see around us today, like erosion, sedimentation, and, to some extent, animal behavior, were also happening in the past. So, we can use the present as a key to understanding what life was like in the past for the fossils that we find today.

Putting Together the Pieces

Once an animal is reconstructed, how do we reconstruct its environment? It is helpful if there are fossil plants from the same site, or from similar sites from the same time period. Ferns today require a specific kind of environment, a climate that is moderate and very wet. Using the present as a key to the past, we could assume that a…

Florissant Fossil Beds NM

Putting Together the Pieces

....fossil fern would need the same kind of climate. When the plants are similar to modern day ones, we can look at modern day plants, their growth forms, the climate they live in, and the associations they have with other plants to come up with a picture of the past. Just as fossil animals can show us how that type of animal has evolved through time, plants show evolution and reflect a changing climate.

Putting Together the Pieces

John Day Fossil Beds in Oregon is one of the worlds most complete fossil records and is an excellent example of how climate and life change through time. It is unique because the fossils found there span a vast amount of geologic time, nearly 40 million years. There are four distinct layers, or formations that represent life that existed at different points in time.

Putting Together the Pieces

Clarno Formation: 48 to 35 million years ago this area (now in eastern Oregon) was closer to the coast and was covered with "paratropical" evergreen forests. (Paratropical: between tropical and subtropical).

Putting Together the Pieces

We know of these forests because of the splendid samples of fossil seeds, nuts, fruits, leaves, branches, and roots. The Clarno locality is one of the finest known fossil plant localities on the planet, with hundreds of species, many new to science, preserved. The Nutbeds were formed as a delta in a lake. Because of the variety of plants fossilized we have a very detailed look at the ancient environment and can make assumptions about the climate.

Putting Together the Pieces

John Day Formation: By 32 million years ago the climate had become cooler, and developed into a warm temperate climate with deciduous forests. This formation spans more than 20 million years and more than 120 species of mammals have been found in it, including the "rhinoceros" (Diceratherium) seen in the center of the slide, Miohippus (a three toed horse), Sabre toothed "tigers" (one is seen in the tree) and an early "dog" Mesocyon.

Putting Together the Pieces

This early dog, a mesocyon, was identified by the teeth and features of the skull that are similar to modern day members of the dog family.

Putting Together the Pieces

The metasequoia, or Dawn Redwood, grew in the ancient forests. It is in the same family as the redwoods that grow today in California and Oregon. For years it was considered to be an extinct species, but living trees were discovered in China.

Putting Together the Pieces

The Mascall Formation dates from about 15 million years ago. The ash deposits and erosional outwash materials that became the Mascall Formation were from the Strawberry Volcanoes that stood to the south at that time. Lush grasslands and hardwood forests, similar to the eastern U.S., were home to a great variety of animals that we might recognize as horses, camels and deer as well as bears, weasels, dogs, and cats.

Putting Together the Pieces

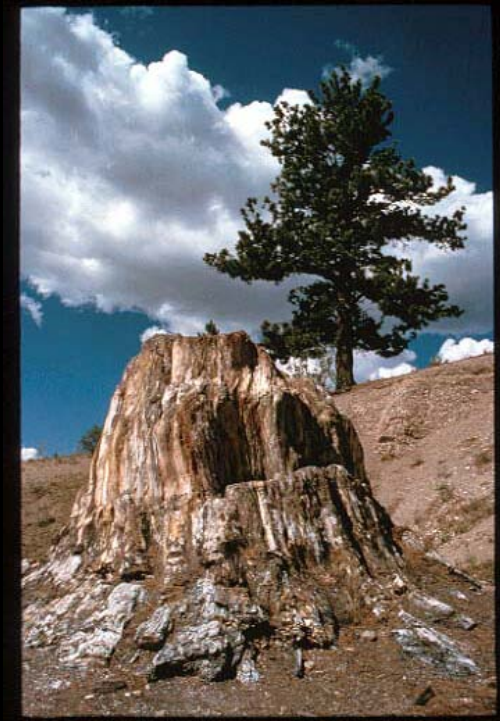
The Merychippus was a pony like horse. This one was caught up in the volcanic eruptions and buried quickly enough that it was preserved as a fossil rather than rotting away.

Putting Together the Pieces

The Rattlesnake Formation represents the Miocene epoch, and dates from 7 to 5 million years ago. The populations had adjusted to a significantly dryer, cooler climate. Grasses were more abundant than shrubs and trees, and grazers were more abundant than browsers. Pictured here are; pliohippus (in the modern lineage of the horse), dog, short face bear, peccaries, and tetralophodon (in the elephant family).

Putting Together the Pieces

Florissant Fossil Beds in Colorado provides another unique look at an ancient environment because of the abundance of very detailed plant and insect fossils dating from nearly 35 million years ago.

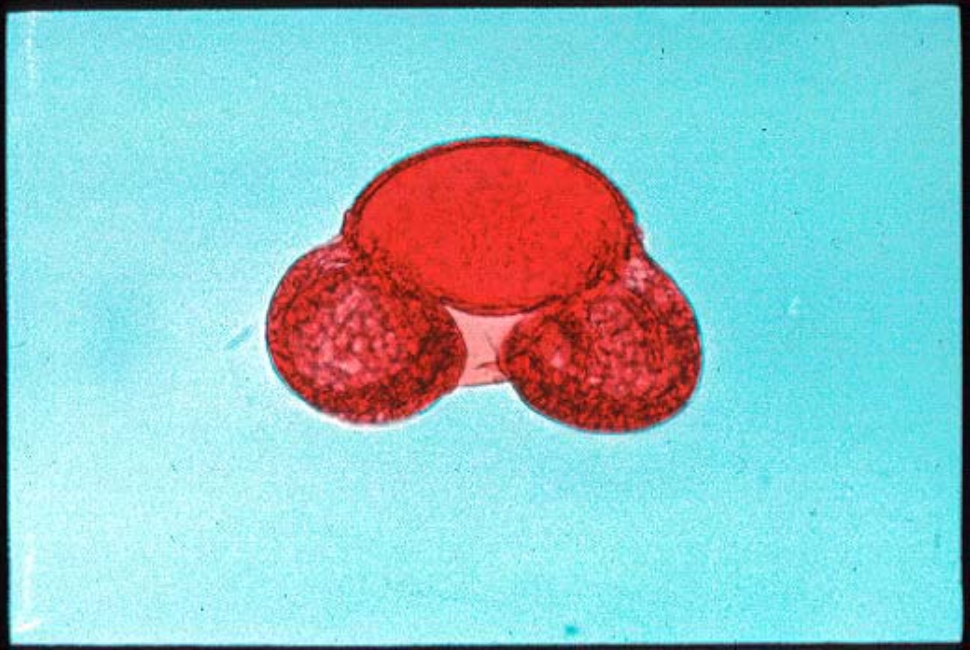


In addition to the detailed carbon fossils, there are huge petrified remains of redwood trees. We can look at these petrified stumps and draw two different conclusions. Either the climate was the same back then as it is in modern day Colorado and redwood trees back then had very different requirements than the ones today do or.....

we can infer that the ancient redwoods had similar needs as the present day redwoods do; moderate climate and lots of moisture. The carbon fossils of plants and insects are also similar to modern day plants and insects that live in very warm humid climates and Florissant gives us a detailed look at how changing climate affects vegetation.

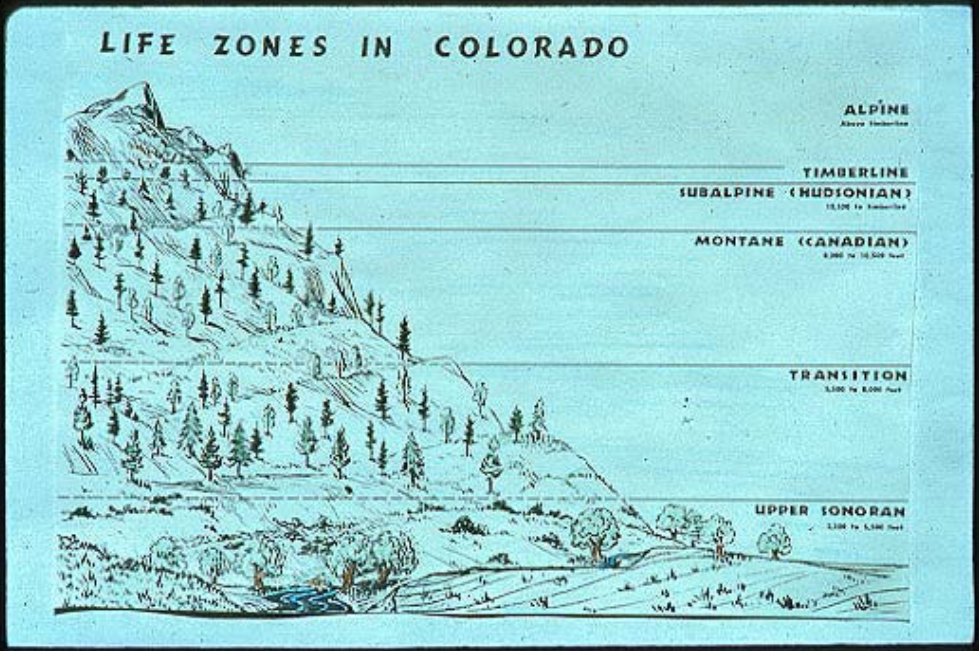
Putting Together the Pieces

Trees and plants that grew next to the lake dropped leaves, twigs and branches into water where they were covered with volcanic ash and fossilized. The ancient winds of the Florissant region carried pollen that also fell into the lake and became fossilized.



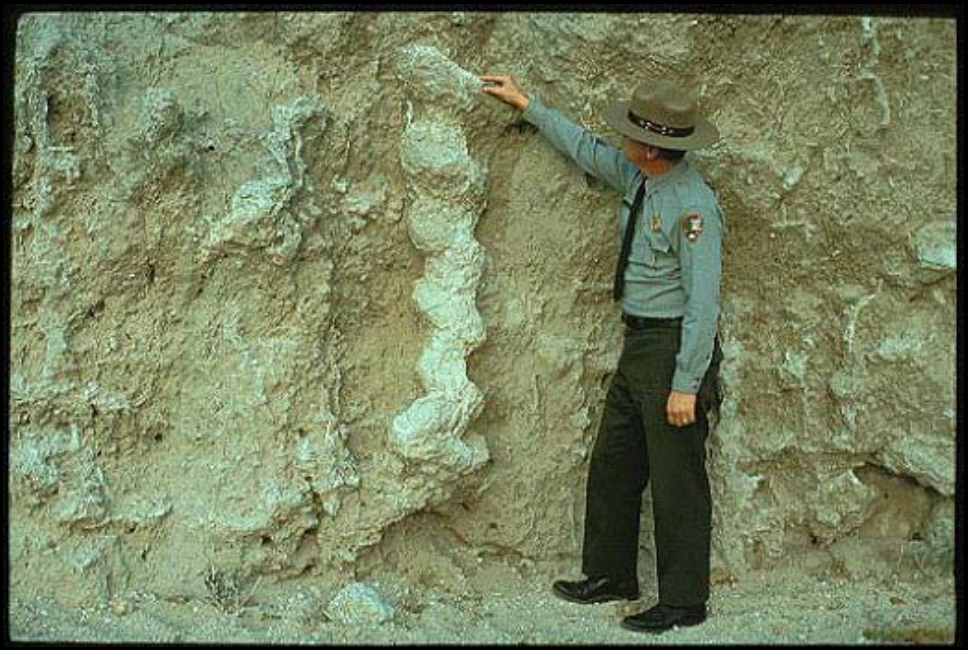
Putting Together the Pieces

Because of the very detailed fossils that were formed at Florissant we can see this fossil pollen (if we use a microscope). Because each kind of plant has its own, unique shape of pollen, like a fingerprint, and because pollen can be carried for great distances by the wind, the fossil pollen gives us a look at the vegetation of the entire region 35 million years ago.



Putting Together the Pieces

Today Colorado has several different life zones which are dependent on altitude. It appears the same was true of the area in ancient times with the valley floor being very lush, covered with redwood forests, and the drier sites above the valley being more similar to northern Mexico.



Putting Together the Pieces Slide 42 of 48

Sometimes there are mysteries of the past that take years to solve. Sometimes a new or unique approach is used to figure them out, or sometimes they are never solved. These Daemonelix, or Devil's Corkscrews, as they were called, were a devil of a thing to figure out for the paleontologists who were studying the fossils of Agate Fossil Beds National Monument. Originally they were thought to be the filled in holes of ancient plant roots. Then, bones of paleocastor were found at the bottom of one, proving they were the trace fossils of this animal's activities. Paleocastor is an ancestral beaver that was land oriented rather than water oriented.

Putting Together the Pieces

The lifestyle of Paleocastor was similar to the prairie dog, except that it had a unique, spiraling burrow. Some of these burrows were filled with sediment and turned into trace fossils.

Putting Together the Pieces

This is a scene from Dinosaur National Monument. For a number of years visitors could watch paleontologists at work, removing surrounding rock from dinosaur fossils. At this point, they are no longer removing any more material from the quarry walls as so much evidence is present in the rocks surrounding the bones.

Putting Together the Pieces

Although Dinosaur National Monument is best known for its large dinosaurs, a great effort is being made to understand the complete ecosystem of the Jurassic Morrison Formation. Mammals, amphibians, plants, sediments and trackways are all being studied, and information from them is used to yield a more complete picture of the past. (trackways are the preserved footprints of animals and are considered trace fossils)

Putting Together the Pieces

The situation at Dinosaur National Monument is representative of the ways that new techniques are used to study the past. The science of paleontology is an evolving science and has changed greatly in the past century.

Putting Together the Pieces

As new techniques are discovered they change the way we look at fossils and the way we recreate the past.

Putting Together the Pieces

The National Park Service continues to be a leader in using these techniques to better understand our past and, through protection of these world class fossils sites, preserves them for future generations to study and learn from.